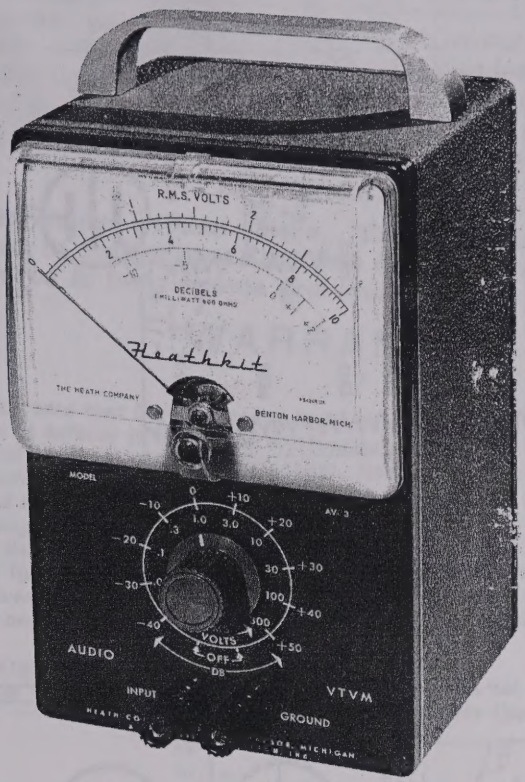
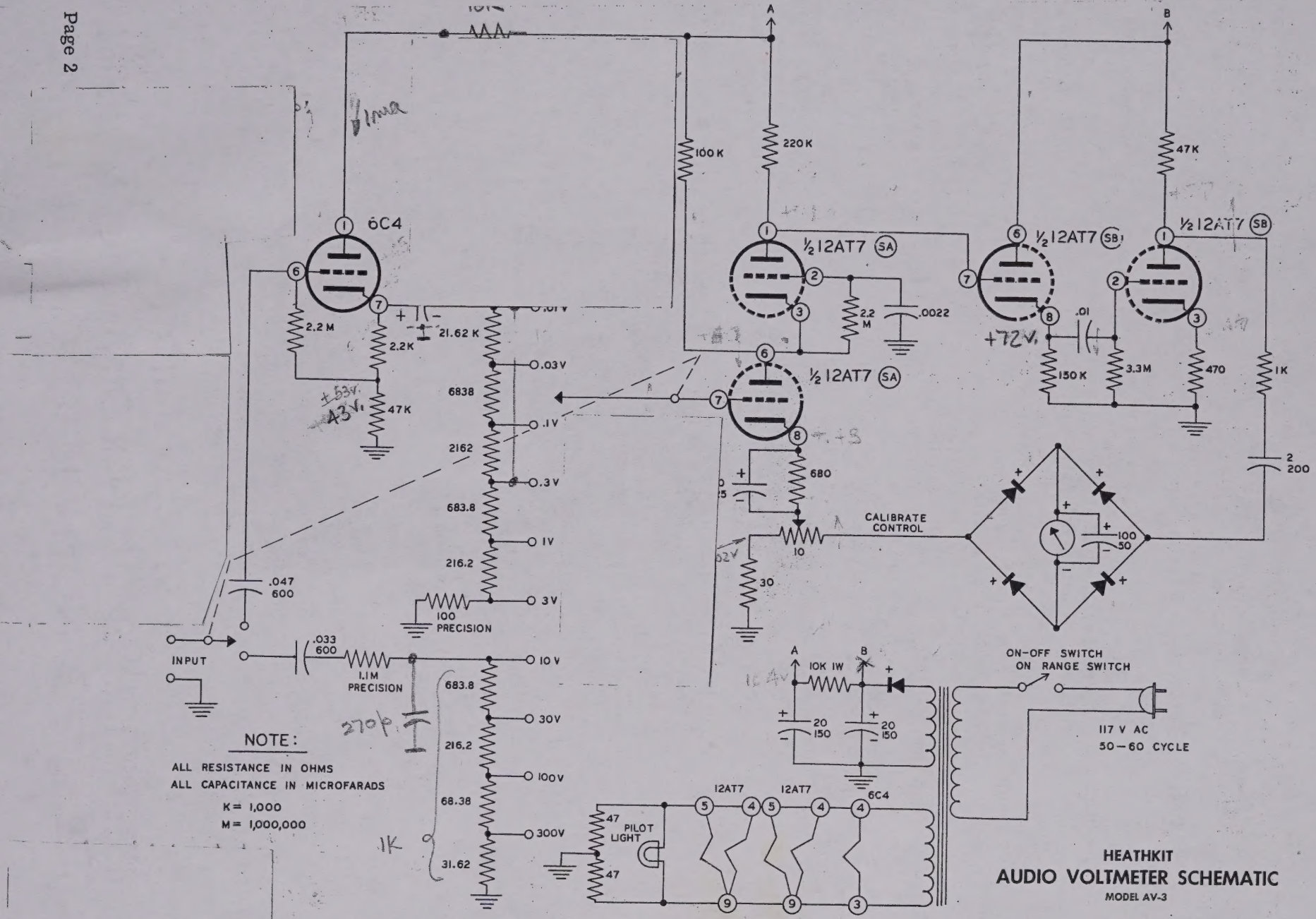
ASSEMBLY AND OPERATION OF THE HEATHKIT AUDIO VACUUM TUBE VOLTMETER

MODEL AV-3



SPECIFICATIONS

Frequency Response:	±1 db. 10 cps to 400 kc, .01 volt through 100 volt ranges. ±2 db from 10 cps to 40 kc, 300 volt range.
Sensitivity:	10 millivolts full scale (lowest range).
Range:	
Volts:	0.01, 0.03, 0.1, 0.3, 1, 3, 10, 30, 100, 300 volts, RMS, full scale.
Decibels:	Total range -52 db to +52 db. Scale -12 to +2 db. (1 mw-600 ohm). Ten switch selected ranges from -40 to +50 db.
Input Impedance:	1 megohm at 1 kc.
Accuracy:	Within 5% of full scale.
Multipliers:	1% precision type.
Meter:	4 1/2" streamlined case with 200 microampere movement.
Tube Complement:	Two 12AT7. One 6C4.
Power Supply:	Power transformer, selenium rectifier with resistance-capacitance filter.
Power Requirement:	105 - 125 volts AC, 50-60 cycles, 10 watts.
Dimensions:	7 3/8" high x 4 11/16" wide x 4 1/8" deep.
Net Weight:	3 1/2 lbs.
Shipping Weight:	5 lbs.


6C4
½12AT7 (SA)
½12AT7 (SB)
½12AT7 (SB)
½12AT7 (SA)
100 K
220 K
47 K
2.2 M
2.2K
21.62 K
47K
2.2 M
.0022
.01
150 K
3.3M
470
1K
680
10
30
2
200
100
50
6838
2162
683.8
216.2
100
PRECISION
.03 V
.1 V
.3 V
1 V
3 V
.047
600
.033
600
1.1M
PRECISION
10 V
30V
100V
300V
68.38
31.62
1K
270p
INPUT
CALIBRATE
CONTROL
+63V
43V
+72V
10K 1W
20
150
20
150
12AT7
12AT7
6C4
47
PILOT
LIGHT
47
ON-OFF SWITCH
ON RANGE SWITCH
117 V AC
50—60 CYCLE
NOTE:
ALL RESISTANCE IN OHMS
ALL CAPACITANCE IN MICROFARADS
K= 1,000
M= 1,000,000
HEATHKIT
AUDIO VOLTMETER SCHEMATIC
MODEL AV-3

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A TAG TO THE INSTRUMENT GIVING NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

SPECIFICATIONS

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

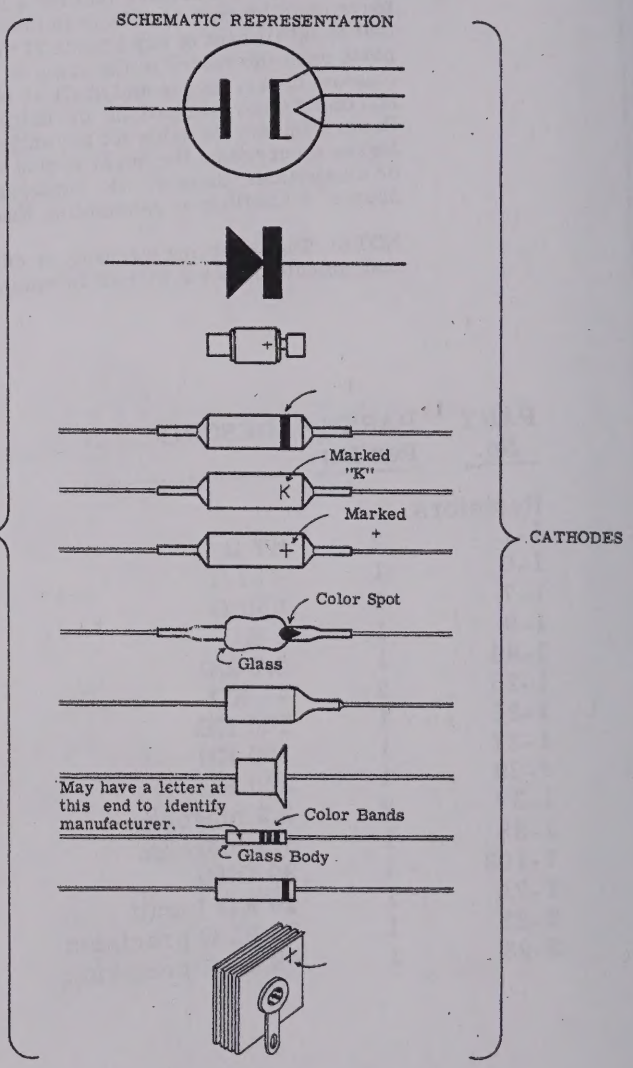
PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-1	2	47 Ω
1-6	1	470 Ω
1-7	1	680 Ω
1-9	1	1 KΩ
1-44	1	2.2 KΩ
1-25	2	47 KΩ
1-26	1	100 KΩ
1-27	1	150 KΩ
1-29	1	220 KΩ
1-37	2	2.2 megohm
1-38	1	3.3 megohm
1-108	1	30 Ω 5%
1-9A	1	10 KΩ 1 watt
2-22	1	31.62 Ω precision
2-23	1	68.38 Ω precision
Resistors, Continued		
2-4	1	100 Ω precision
2-25	2	216.2 Ω precision
2-28	2	683.8 Ω precision
2-31	1	2162 Ω precision (2.162 KΩ)
2-33	1	6838 Ω precision (6.838 KΩ)
2-39	1	21.62 KΩ precision
2-116	1	1.1 megohm precision
Capacitors		
23-37	1	.0022 μfd plastic tubular
21-16	1	.01 μfd disc ceramic
23-44	1	.033 μfd plastic tubular
23-45	1	.047 μfd plastic tubular
23-17	1	2 μfd metallized tubular
25-4	1	10 μfd 25 volt electrolytic
25-19	1	20 μfd 150 volt electrolytic
25-7	1	20-20 μfd 150 volt electrolytic
25-28	1	100 μfd 50 volt electrolytic

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Tubes-Lamp-Sockets		
411-4	1	6C4 tube
411-24	2	12AT7 tube
412-4	1	#50 pilot lamp
434-34	1	7-pin miniature socket
434-56	2	9-pin miniature socket
434-47	1	Pilot lamp socket
Binding Posts-Terminals-Knob		
75-17	4	Insulator bushing
100-M16B	1	Binding post cap, black
100-M16R	1	Binding post cap, red
427-2	2	Binding post base
431-23	1	Terminal board
431-2	2	2-lug terminal strip
431-3	1	3-lug terminal strip
431-10	1	3-lug terminal strip (center lug-ground)
431-5	1	4-lug terminal strip
70-5	1	Banana plug sleeve, black
70-6	1	Banana plug sleeve, red
438-13	2	Banana plug
439-1	1	Probe, red
462-19	1	Knob
Transformer-Diode-Meter		
54-2	1	Power transformer
56-4	4	Crystal diode
57-13	1	Selenium rectifier
407-8A	1	Meter
Sheet Metal Parts		
200-M113	1	Chassis
204-M29	1	Chassis bracket
203-105F144	1	Panel
90-17	1	Cabinet
Hardware		
250-2	6	3-48 screw
250-8	2	#6 sheet metal screw
250-9	6	6-32 screw
250-83	2	10-24 screw
252-1	6	3-48 nut
252-3	9	6-32 nut
252-7	2	Control nut
253-10	1	Nickel control washer
254-7	6	#3 lockwasher
254-1	7	#6 lockwasher
254-4	2	Control lockwasher
259-1	3	#6 solder lug
Controls-Switches		
11-26	1	10 Ω control
63-129	1	12-position RANGE switch

PART No.	PARTS Per Kit	DESCRIPTION
Wire-Sleeving		
89-1	1	Line cord
344-1	1	length Hookup wire
341-1	1	Black test lead wire
341-2	1	Red test lead wire
206-4	1	length Spirashield
346-1	1	length Sleeving
346-5	1	length 1/4" sleeving
346-6	1	length 3/8" sleeving
Miscellaneous		
73-1	2	Rubber grommet
211-4	1	Handle
260-1	1	Alligator clip
261-1	4	Rubber feet
595-147	1	Instruction manual



TUBE, GERMANIUM, SILICON AND SELENIUM DIODES

tage, dividing the output by the input voltage. Checks at the secondary of an output transformer for voltage gain are not feasible however, since the last stage in a power amplifier provides power gain at low impedance, rather than voltage gain.

Ripple on the output of power supplies can be measured by connecting the AV-3 across the supply.

Amplifier noise measurements are made by running the amplifier to full output power at a reference frequency such as 400 or 1000 cycles and then turning off the signal source, leaving it connected to the amplifier input. The reading in volts or db should be noted at full output and read again after the signal source is killed. The difference between the two readings is the noise output level in volts or db below the specified output.

BIBLIOGRAPHY

Langford-Smith, RADIOTRON DESIGNERS HANDBOOK, 4th Edition, Chapter 19, Published by RCA.

Rider, J. F., VACUUM TUBE VOLTMETERS, 2nd Edition.

Turner, BASIC ELECTRONIC TEST INSTRUMENTS, Rinehart, 1953.

"A Vacuum Tube Voltmeter for Audio Frequencies," ELECTRONICS, December 1940.

"An Electronic A. C. Voltmeter," RADIO AND TELEVISION NEWS, February 1951.

"Practical Sound Engineering," RADIO AND TELEVISION NEWS, May 1951.

"Vacuum Tube Voltmeter Using Feedback," RADIO AND TELEVISION NEWS, May 1951.

REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all the following information:

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
B. Identify the type and model number of kit in which it is used.
C. Mention the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SERVICE

If, after applying the information contained in this manual and your best efforts on the unit, you are still unable to obtain proper performance from the Voltmeter, it is suggested that you take advantage of the technical facilities which the Heath Company make available to its customers.

The Technical Consultation Department is maintained for the purpose of providing Heath customers with a personalized technical consultation service; this service is available to you without charge. The technical consultants are thoroughly familiar with all details of the Voltmeter and can usually localize the trouble from a suitable description of the difficulty encountered. It is, of course, necessary that you provide full and complete information concerning your problem when writing to the Technical Consultation Department for assistance. For instance, clearly identify the kit involved, giving the purchase date and, if possible, the invoice number; describe

in detail the difficulty that you have encountered; state what you have attempted to do to rectify the trouble, what results have been achieved, and include any information or clues that you feel could possibly be of value to the consultant who handles your problem. Failure to provide complete descriptive details may lead to incorrect assumptions on the part of the consultant and needless delay in the solution to your problem. Quite frequently, when the information given the consultant is complete, concise and reliable, a diagnosis of the difficulty can be made with confidence and specific instructions given for its correction. If replacement of a component is involved in the correction, the component will be shipped to you, subject to the terms and conditions of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the complete Voltmeter to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a fixed fee of $4.00, plus the price of any additional parts or material required. However, if the Voltmeter is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase and give invoice number, if possible.

Local Service by Authorized Heathkit Dealers is also available and often will be your fastest, most efficient method of obtaining service for your Heathkits. Although you may find charges for local service somewhat higher than those listed in Heathkit manuals (for factory service), the amount of increase is usually offset by the transportation charges you would pay if you elected to return your kit to the Heath Company.

Heathkit dealers will honor the regular 90 day Heathkit Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company. It will be necessary that you verify the purchase date of your kit by presenting your copy of the Heath Company invoice to the authorized dealer involved.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if your local dealer assists you in locating a defective part (or parts) in your Heathkit, or installs a replacement part for you, he may charge you for this service.

Heathkits purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized Heathkit dealer in order to be eligible for parts replacement under the terms of the Warranty.

THESE SERVICE POLICIES APPLY ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUALS. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned NOT repaired.

For information regarding modifications of Heathkits for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic outlet stores. Although the Heath Company welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder, according to information which will be much more readily available from some local source.

This completes the adjustment of the meter. Install the meter in the cabinet and fasten with the two #6 sheet metal screws through the rear of the cabinet into the chassis bracket.

IN CASE OF DIFFICULTY

If, upon completion of careful construction, the instrument fails to operate, proceed as follows:

1. Check the wiring carefully step-by-step. Often having a friend check for you will locate an error consistently overlooked.

2. Inspect visually for malfunctioning, such as tubes not lighting, discoloring of resistors through overheating, etc.

3. Inspect electrically with a voltmeter. The nominal voltages between tube socket pins and chassis are tabulated below. Nominal voltages were measured with a VTVM with 11 megohm input impedance. Lower resistance meters may give lower readings in some instances. Normal deviations due to line voltage and component variation may reach ±20%.

TUBE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
12AT7 (SA)	80	40	60	2.6 AC	2.6 AC	60	0	0-1	2.6 AC
12AT7 (SB)	70	0	0-1	2.6 AC	2.6 AC	130	80	80	2.6 AC
6C4 (SC)	120	IC	2.6 AC	2.6 AC	120	25	60		

NC - No Connection. IC - Internal Connection

When discrepancies occur, investigate the circuit involved. Wiring errors or faulty components may be found upon inspection.

Consistent full scale reading of the meter indicates that the VTVM is oscillating. Careful redress of leads and components will usually clear this up. Rotate control C rapidly back and forth a few times to insure good contact and at the same time, make sure too much feedback does not exist. This is done by rotating the control to its full counterclockwise position before attempting to calibrate the VTVM. Also check the 2 μfd coupling capacitor for excessive leakage..

USING THE AV-3

The Heathkit Model AV-3 Audio Voltmeter has 10 separate voltage ranges allowing measurements up to 300 volts RMS. The voltage markings on the RANGE switch refer to full scale voltage readings. Frequency response is ±1 db from 10 cps to 400 kc, .01 volt through 100 volt ranges; ±2 db from 10 cps to 40 kc, 300 volt range.

When the instrument is set to the lower ranges, the meter may show a residual indication. This is caused by the extreme sensitivity of the circuit. To check for zero indication, the instrument power plug should be reversed in the AC outlet until a minimum reading is obtained. Zero reading should be evident when the input terminals are shorted together. Any residual indication will have no effect on the accuracy of these ranges when readings are made, due to the low impedance of the circuits being tested.

The meter scale is marked 0-3 and 0-10 for voltage measurements. When making measurements on the .03, .3, 3, 30 or 300 volt ranges, read the 0-3 meter scale and adjust the decimal for the correct voltage.

Example: Using the .03 range, the meter reads 2. For correct voltage, move the decimal point two places to the left, i. e. .02 volts.

When making measurements on the .01, .1, 1, 10 or 100 volt ranges, read the 0-10 meter range and adjust the decimal for the correct voltage.

Example: Using the .1 volt range, the meter reads 6.4. For correct voltage, move the decimal two places to the left, i. e. .064 volts.

Due to the high sensitivity of the instrument, the input terminals should not be touched when the meter is set for the lower ranges. Stray electric fields, picked up by the human body will deflect the pointer beyond full scale. Repeated banging may bend the pointer.

Although the pointer may bend by overloading, the electronic circuit is self-limiting. Because of this self-limiting, the maximum current through the meter movement under extreme overload conditions is yet within the safety factor of the meter coil windings. Although the meter may not burn out from severe overloading, other circuit components can be damaged by prolonged overloads.

Using the Decibel Scale: Because the human ear does not respond to the volume of sound in proportion to the signal strength, a unit of measure called the "bel" was adopted. The "bel" is more nearly equivalent to human ratios. Normally the reading is given in 1/10 of a "bel" or "decibel." Different signal levels are adopted by various manufacturers as standard or "0" decibels. The trend within the last few years has been toward the use of 1 milliwatt into a 600 Ω load as "0" db. This reference has been given a special designation of "dbm." This Heathkit is calibrated to read in "dbm" when connected across a 600 Ω load.

When using the AV-3 for db measurement, adjust the RANGE switch until there is a reading on the decibel scale. The meter reading is then either added to or subtracted from the range indication.

Example: Range +20 db, meter indicates -5 db, actual value is +15 db.
Range -10 db, meter indicates -4 db, actual value is -14 db.

Since the decibel is a power ratio or voltage ratio, it may be used as such without specifying the reference level. Thus for instance, a fidelity curve may be run on an amplifier by feeding in a signal of variable frequency but constant amplitude. At a reference frequency of, say 400 cycles, make an initial reading on the AC voltmeter, connected to the output. A suitable load, such as a speaker should be connected to the amplifier output during the test. As the input frequency is varied, amplitude held constant, the output level variation may be noted in db above and below the specified reference level.

When making comparative measurements, the circuit impedances must be considered. Such is the case when measuring overall gain through an amplifier. If the input impedance is the same as the output impedance, the db gain can be measured directly with the AV-3. In the case where the input and output impedance differ, it is necessary to correct each reading mathematically to a common reference level.

Complex Waveforms: This instrument, like most AC voltmeters, is calibrated to read the Root Mean Square (RMS) value of a pure sine wave. This is 70.7% of the peak voltage.

As characteristic of most rectifier type instruments, the meter deflection is proportional to the average value of the input waveform. Thus when measuring odd y shaped waves (square, sawtoothed, pulse), the meter reading must be given special interpretation. Special reading on this subject will be found in the bibliography.

AC VTVM APPLICATIONS

AC voltages at any point in practically any type of circuit can be measured with the VTVM. Filament voltage, power line voltage, noise, output and gain measurements can be made quickly and accurately by connecting the test leads across the point where information is desired. Voltage gain is measured stage by stage or overall by measuring input voltage versus output vol-

( ) Cut a 3 1/2" length of spirashield. Unwind 1 1/2" of wire from one end. Slip a 3 1/2" length of 1/4" insulating sleeving over the spirashield. Place this shield and sleeving over the wire previously connected to RM12 so it passes through the hole in the chassis between sockets SA and SB. The unwound end of the spirashield should be on the opposite side of the chassis from the range switch.

( ) Connect the wire coming through the spirashield to SA7 (S-1).

( ) Connect the shield wire to LB1 (S-8) (use sleeving). Make sure the spirashield does not touch the switch lug SA7.

( ) Mount the chassis bracket using 6-32 hardware. The bracket attaches to the panel by meter mounting screw M4. Refer to Figure 7.

( ) Mount a 3/8" rubber grommet at GB in the chassis bracket.

( ) Pass the line cord through grommet GB. Tie a knot 2" from the end for strain relief. Connect either lead to LE1 (S-2) and the other lead to LE2 (S-2).

( ) Mount a black binding post cap on BB and a red cap on BR.

This completes the wiring of the instrument. Shake out all the loose solder bits and wire clippings. Inspect the wiring carefully. Check lead dress (bare leads contacting metal parts, components touching moving parts) and inspect each connection carefully for proper soldering.

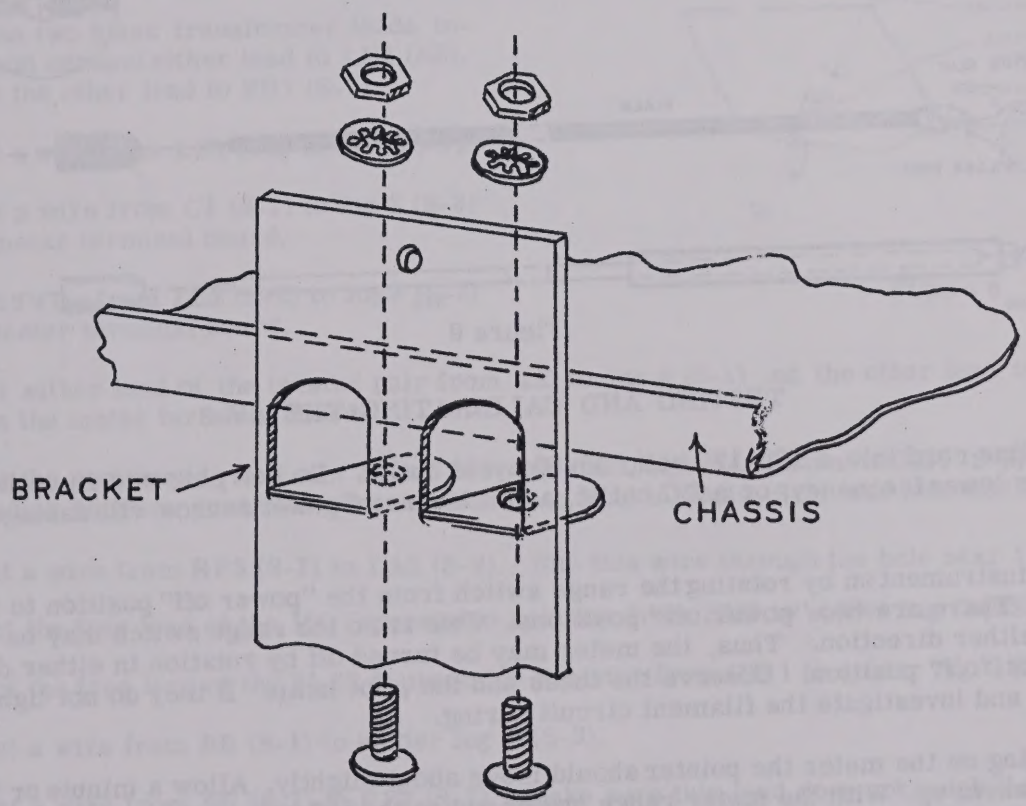


Figure 7

( ) Install the knob on the switch shaft. Make sure the knob is positioned properly. Figure 5 on Page 12 shows the switch on the .01 volt range.

IMPORTANT WARNING: MINIATURE TUBES CAN BE EASILY DAMAGED WHEN PLUGGING THEM INTO THEIR SOCKETS. THEREFORE, USE EXTREME CARE WHEN INSTALLING THEM. WE DO NOT GUARANTEE OR REPLACE MINIATURE TUBES BROKEN DURING INSTALLATION.

( ) Install 12AT7 tubes in sockets SA and SB and a 6C4 tube in socket SC.

( ) Prepare the cabinet by installing the handle with 10-24 screws and by pushing the rubber feet into the four holes in the bottom. See Figure 8.

Figure 8

( ) Strip and tin both ends of the 36" lengths of black and red test lead wire.

( ) Fasten a black banana plug on one end of the black lead and an alligator clip on the other end as shown in Figure 9.

( ) Fasten a red banana plug on one end of the red lead and a red probe on the other end as shown in Figure 9.

The AV-3 Audio Vacuum Tube Voltmeter is now ready for testing and calibration. This should be done before placing the meter in the case.

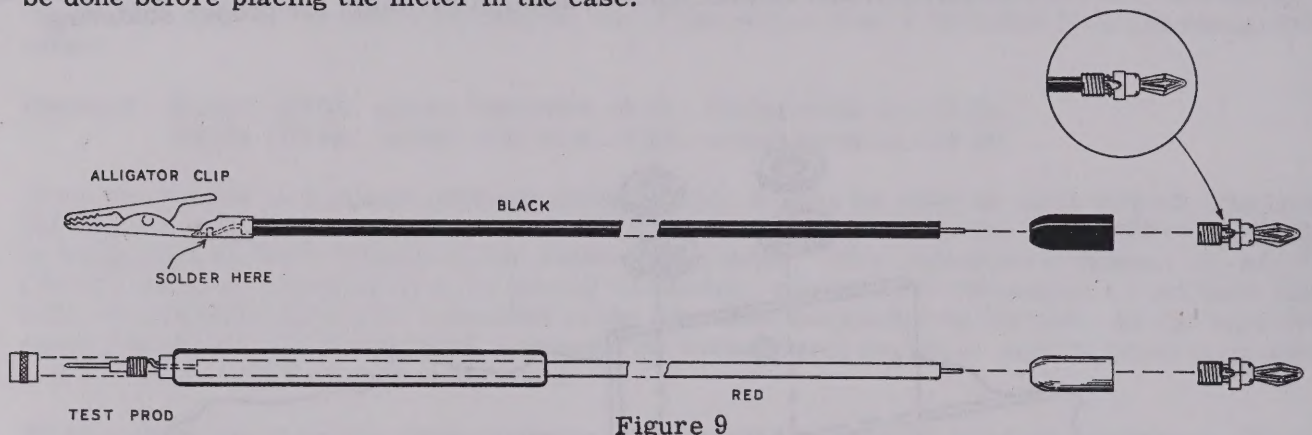


Figure 9

TESTING AND CALIBRATING THE AV-3

Plug the line cord into a 105-125 volt, 50-60 cycle outlet. Do not plug into an outlet of higher voltage or lower frequency, or a DC outlet, as an incorrect power source will damage the transformer.

Turn the instrument on by rotating the range switch from the "power off" position to the 300 volt position. There are two "power off" positions. This is so the range switch may be turned on or off in either direction. Thus, the meter may be turned off by rotation in either direction to the nearest "off" position. Observe the tubes and the pilot lamp. If they do not light, turn the power off and investigate the filament circuit wiring.

Upon turning on the meter the pointer should move about slightly. Allow a minute or two for the meter to warm up. With the meter range switch set to the 300 volt range, connect the input terminals to the 117 volt AC line. (CAUTION: The 117 volt line is dangerous. Proceed with care.) Adjust the 10 Ω calibrate control C until the meter needle reads 117 volts on the 300 volt scale. If an accurate AC meter is at hand, the meter can be calibrated against it.

( ) Cut one lead of a 100 Ω precision resistor to a length of 1/2". Connect this lead to RM5 (S-2). Leave the other end free.

( ) Connect a 683.8 Ω precision resistor between RM6 (S-2) (use sleeving) and RM7 (NS).

( ) Connect a 2162 Ω (2.162 KΩ) precision resistor between RM7 (S-2) and RM8 (NS).

( ) Connect a 6838 Ω (6.838 KΩ) precision resistor between RM8 (S-2) and RM9 (NS).

( ) Connect a 21.62 KΩ precision resistor between RM9 (S-2) and RM10 (NS).

( ) Connect a 1.1 megohm precision resistor between RF4 (NS) and RM4 (S-2).

( ) Connect a .033 μfd 600 volt plastic tubular capacitor between RF11 (S-1) and RF4 (S-2). This capacitor should lie close to the panel when the switch is mounted on the panel.

FINAL ASSEMBLY AND WIRING

( ) Mount a binding post on the panel at BR. Refer to Figure 6 for proper procedure. Refer to Pictorial 4.

( ) Mount the chassis on the panel. At the top, the chassis is held by meter mounting screw M1. The bottom of the chassis is held by binding post BB, which is mounted at this time.

( ) Mount the range switch on the panel using a lockwasher between the switch and the panel and a flat washer and nut on the front of the panel.

( ) Twist the two black transformer leads together and connect either lead to LE2 (NS). Connect the other lead to RR7 (S-1).

( ) Connect a wire from LE1 (NS) to RR8 (S-1).

( ) Connect a wire from C1 (S-1) to lug 2 (S-3) on the meter terminal board.

( ) Connect a wire from LB2 (S-2) to lug 3 (S-2) on the meter terminal board.

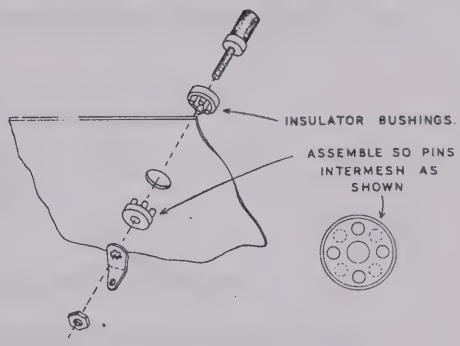


Figure 6

( ) Connect either lead of the twisted pair from LD to lug 4 (S-1) and the other lead to lug 5 (S-1) on the meter terminal board.

( ) Connect the positive (+) lead of a 20 μfd 150 volt electrolytic capacitor to LB4 (S-2). Make this lead as short as possible. Connect the other lead to RM10 (S-2) (use sleeving).

( ) Connect a wire from RF5 (S-1) to LA3 (S-2). Run this wire through the hole near LA3.

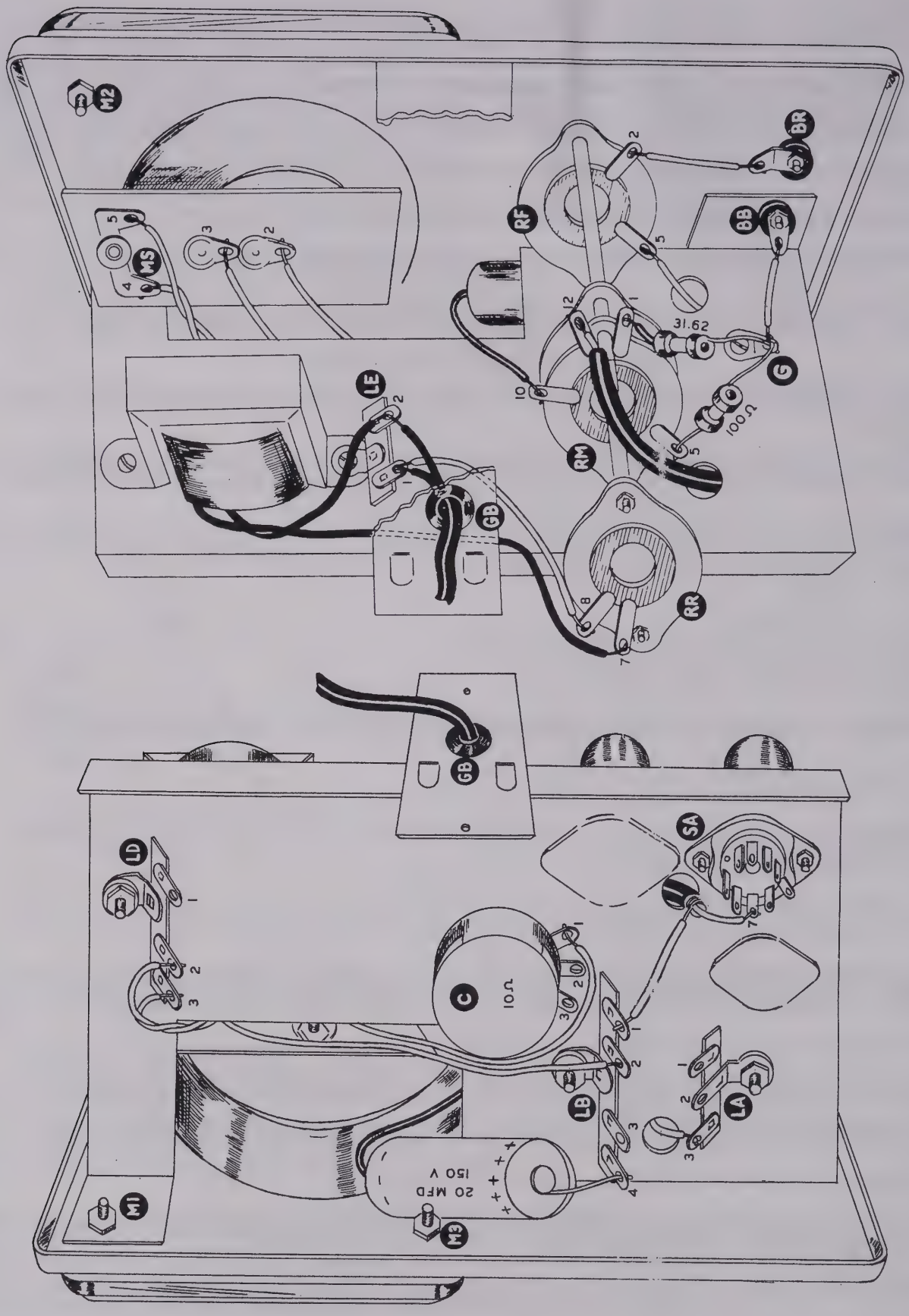
( ) Connect the free lead of the 100 Ω precision resistor from RM5 to solder lug G (NS).

( ) Connect the free lead of the 31.62 Ω precision resistor from RM1 to solder lug G (NS).

( ) Connect a wire from BB (S-1) to solder lug G (S-3).

( ) Connect a wire from BR (S-1) to RF2 (S-1). Make sure this lead does not touch the lead of the .033 capacitor connected to RF4.

( ) Connect one end of a 5" length of wire to RM12 (S-1). Leave the other end free.

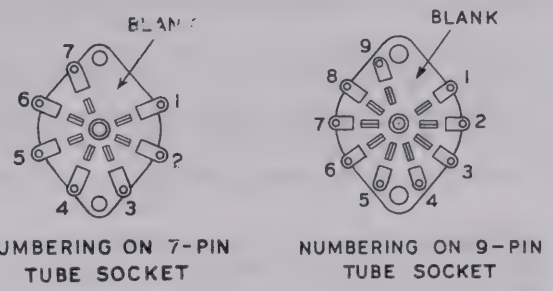

M2
M3
LE
GB
RF
BR
BB
G
RM
RR
31.62
.001
GB
SA
LD
C
.01
LB
LA
M1
M3
20 MFD
150 V

PICTORIAL 4

( ) Connect the negative (-) lead of the same capacitor to LD1 (NS).

( ) Cut and strip two 8 1/2" lengths of hookup wire. Connect one wire to LD2 (NS) and the other wire to LD3 (NS). Twist the wires together and dress along the edge of the chassis as shown in Pictorial 3. Connect either wire of this twisted pair to SB9 (NS). Connect the other lead through SB5 (S-1) to SB4 (NS). See Figure 4.

( ) Cut and strip two 3" lengths of hookup wire. Twist the leads together. Connect either lead of one end of this twisted pair to SB9 (S-2) and the other lead to SB5 (S-2). Dress this pair along the edge of the chassis. Connect either lead of the other end to SA9 (NS) and the other lead through SA4 (S-1) to SA5 (NS).



NUMBERING ON 7-PIN TUBE SOCKET

NUMBERING ON 9-PIN TUBE SOCKET

Figure 4

( ) Connect a wire from SA9 (S-2) to SC3 (S-1).

( ) Connect a wire from SA5 (S-2) to SC4 (S-1).

( ) Cut and strip two 4" lengths of hookup wire and twist together. Connect either lead of one end to LD2 (NS) and the other lead to LD3 (NS). Bend this twisted pair around the cut-out in the chassis. Do not connect the other end at this time.

( ) Connect a 47 Ω (yellow-violet-black) resistor between LD2 (S-4) and LD1 (NS).

( ) Connect a 47 Ω (yellow-violet-black) resistor between LD3 (S-4) and LD1 (NS).

( ) Connect a wire from LD1 (S-5) to LB1 (NS).

( ) Connect a wire from R1 (S-1) to LC2 (NS).

( ) Connect a 10 KΩ (brown-black-orange) 1 watt resistor between LC1 (NS) and LC2 (NS).

( ) Connect a wire from LC2 (NS) to SB6 (S-1).

( ) Connect a 220 KΩ (red-red-yellow) resistor between LC1 (NS) (use sleeving) and SB7 (NS) (use sleeving).

( ) Connect a wire from SB7 (S-2) to SA1 (S-1).

( ) Connect the positive (+) lead of a 10 μfd 25 volt electrolytic capacitor to SA8 (NS). Connect the negative (-) lead to C2 (NS). Make sure this capacitor does not cover the hole in the chassis between SA and SB.

( ) Connect one lead of a 680 Ω (blue-gray-brown) resistor to SA8 (S-2). Connect the other lead to C2 (S-2).

( ) Connect a wire from LC1 (S-4) to SC1 (NS).

( ) Connect a 1 KΩ (brown-black-red) resistor between SB1 (NS) and LB2 (NS).

( ) Connect a 47 KΩ (yellow-violet-orange) resistor between SB1 (S 2) (use sleeving) and LC2 (S-5) (use sleeving).

( ) Connect a wire from LB1 (NS) to LA2 (NS).

(✓) Connect a 150 KΩ (brown-green-yellow) resistor between SB8 (NS) (use sleeving) and LB1 (NS).

(✓) Connect a 3.3 megohm (orange-orange-green) resistor between SB2 (NS) and LB1 (NS).

(✓) Connect a 470 Ω (yellow-violet-brown) resistor between SB3 (S-1) and LB1 (NS).

(✓) Connect a 30 Ω (orange-black-black) 5% resistor between C3 (S-1) and LB1 (NS).

(✓) Connect a .0022 μfd plastic tubular capacitor between LB1 (NS) and LB3 (NS).

(✓) Connect a wire from LB3 (S-2) to SA2 (NS).

(✓) Connect a wire from LB4 (NS) to SC7 (NS).

(✓) Connect one lead of a 2.2 megohm (red-red-green) resistor through SA6 (NS) to SA3 (S-1). Make sure that this lead does not short against pins 4 and 5 of socket SA. Connect the other lead to SA2 (S-2).

(✓) Connect a 100 KΩ (brown-black-yellow) resistor between SA6 (S-2) and SC1 (S-2).

(✓) Connect a 2.2 KΩ (red-red-red) resistor between SC7 (S-2) and LA1 (NS).

(✓) Connect a 2.2 megohm (red-red-green) resistor between SC6 (NS) and LA1 (NS).

(✓) Connect a 47 KΩ (yellow-violet-orange) resistor between LA1 (S-3) and LA2 (S-2).

(✓) Connect a .047 μfd 600 volt plastic tubular capacitor between SC6 (S-2) and LA3 (NS).

(✓) Connect a .01 μfd disc ceramic capacitor between SB2 (S-2) (use sleeving) and SB8 (S-2).

RANGE SWITCH WIRING

( ) Place the switch as shown in Figure 5. The sections from the panel out will be designated RF, RM and RR. The lugs will be numbered clockwise, viewed from the rear of the switch, starting just above the screw on the left. When the notation RM4 is used, it will refer to lug 4 on the middle section.

( ) Connect a 68.38 Ω precision resistor between RM1 (NS) and RM2 (NS). Position the resistor as shown in Figure 5.

( ) Cut one lead of a 31.62 Ω precision resistor to a length of 1". Connect this lead to RM1 (S-2) (use sleeving). Leave the other end free.

( ) Connect a 216.2 Ω precision resistor between RM2 (S-2) and RM3 (NS).

( ) Connect a 683.8 Ω precision resistor between RM3 (S-2) and RM4 (NS).

( ) Connect a 216.2 Ω precision resistor between RM5 (NS) and RM6 (NS).

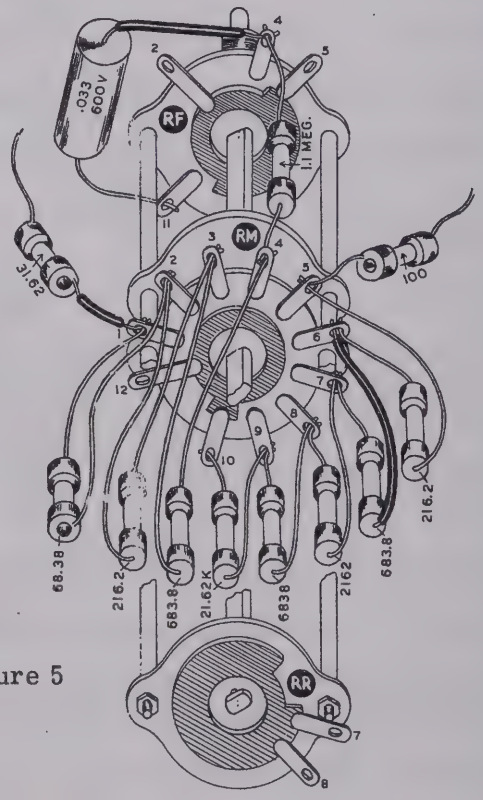


Figure 5

(✓) Connect the cathode lead of a crystal diode to the positive (+) terminal of the meter (NS). Connect the other lead to lug 2 (NS).

(✓) Connect the cathode lead of a crystal diode to lug 2 (NS). Connect the other lead to the negative (-) meter terminal (NS).

(✓) Connect either lead of a 2 μfd, 200 volt metallized tubular capacitor to lug 3 (NS) (use sleeving). Connect the other lead to lug 1 (S-3) (use sleeving).

(✓) Connect the positive (+) lead of a 100 μfd 50 volt electrolytic capacitor to the positive (+) terminal of the meter (S-3) (use sleeving). Connect the negative (-) lead of the capacitor to the negative (-) meter terminal (S-3). The capacitor should lie below the meter studs as shown in Figure 1.

MOUNTING PARTS ON CHASSIS

(✓) Mount 9-pin miniature sockets in locations SA and SB. Use 3-48 screws, lockwashers and nuts. Refer to Pictorial 1 for pin orientation, noticing the location of the blank space on the socket. Bend the ground lugs on the sockets toward the chassis.

(✓) Mount a 7-pin miniature socket in location SC. Use 3-48 hardware.

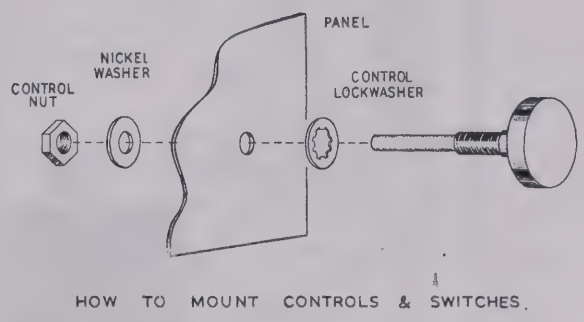
(✓) Mount the 10 Ω calibration control in location C. Be sure to have the lugs directed as shown in Pictorial 1. Use a control lockwasher between the control and the panel. Do not use a control flat washer on this control. See Figure 3 for proper mounting procedure.

(✓) Mount a 3/8" rubber grommet at GA.

(✓) Mount a selenium rectifier at R. Use a #6 lockwasher and a 6-32 nut. Note that the plus (+) terminal of the rectifier is away from the chassis cut-out. Bend the lugs outward as shown in Pictorial 1.

(✓) Mount a 3-lug (1 ground) terminal strip at LA. Use 6-32 hardware. Under the head of the screw mount a solder lug at G. Refer to Pictorials 1 and 2 for proper orientation. Use a 6-32 screw, lockwasher and nut.

(✓) Mount a 4-lug terminal strip at LB. Use 6-32 hardware.



HOW TO MOUNT CONTROLS & SWITCHES.

Figure 3

(✓) Mount the power transformer on the other side of the chassis using the mounting holes LC and LD. Under the head of the screw mount a 2-lug terminal strip at LE. This is on the same side of the chassis as the transformer. See Pictorial 2. Under the lockwasher and nut at LC mount a 2-lug terminal strip and at LD mount a 3-lug terminal strip. Note that the red and yellow leads go through grommet GA. The black leads remain on the same side of the chassis as the transformer.

WIRING CHASSIS

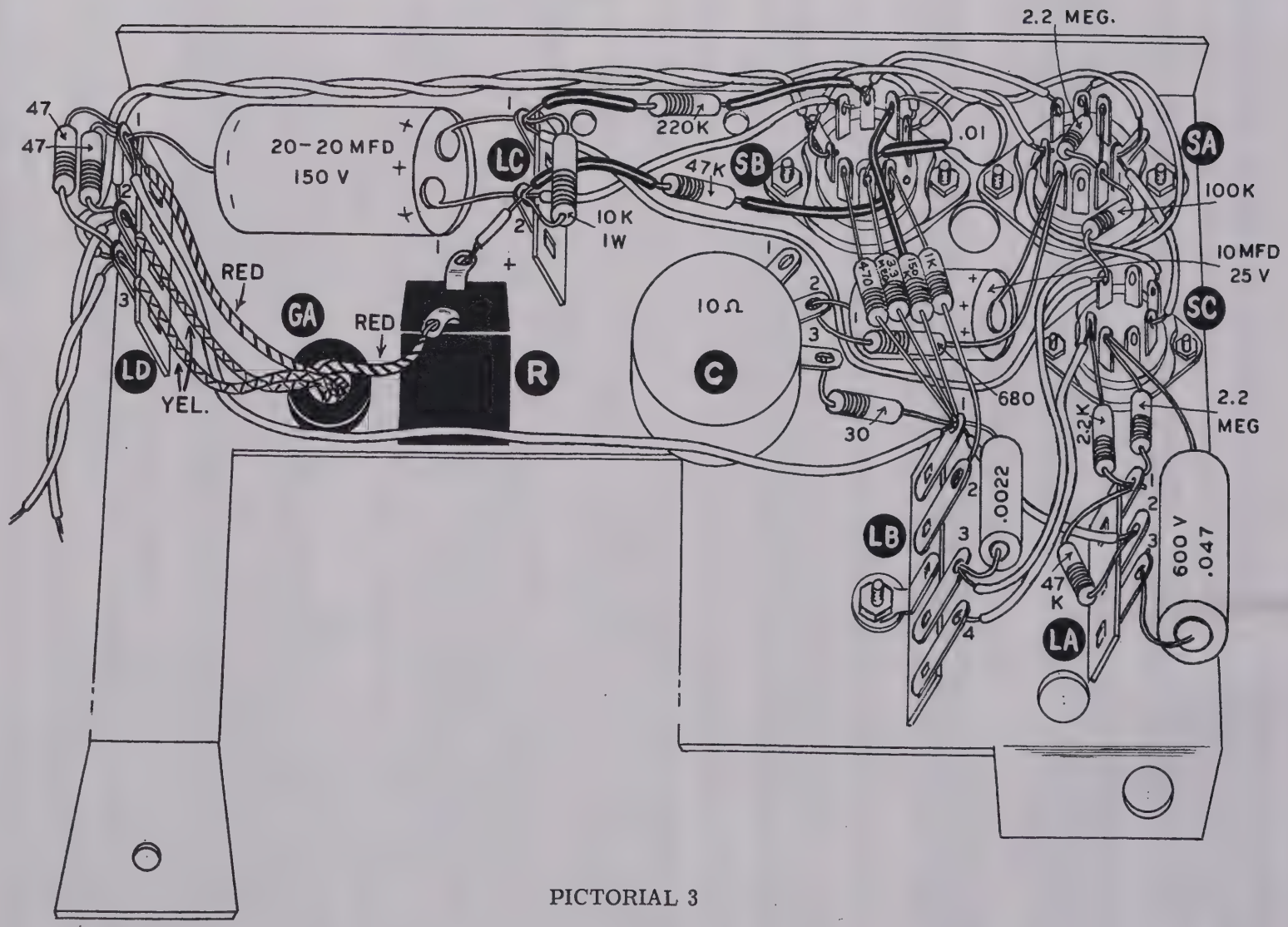
(✓) Connect either of the red transformer leads to R2 (S-1). Refer to Pictorial 3.

(✓) Connect the other red transformer lead to LD1 (NS).

(✓) Connect either of the yellow transformer leads to LD2 (NS). Connect the other yellow lead to LD3 (NS).

(✓) Connect either positive (+) lead of a 20-20 μfd 150 volt electrolytic capacitor to LC1 (NS).

(✓) Connect the other positive (+) lead of the same capacitor to LC2 (NS).


2.2 MEG.
47
47
20-20 MFD
150 V
LC
220K
47K
SB
.01
SA
100K
10K
1W
10MFD
25 V
SC
RED
GA
RED
10Ω
C
R
LD
YEL.
680
30
2.2
MEG
2.2K
.0022
LB
600 V
.047
47
K
LA

PICTORIAL 3

METER SUB-ASSEMBLY

(✓) Mount the meter on the panel using the lockwashers and nuts which are with the meter. Do not tighten the nuts at M1 and M4. They will be used later for mounting the chassis.

(✓) Mount the pilot light socket on the terminal board at MS. Solder the socket to terminals 4 and 5 as shown in Figure 1.

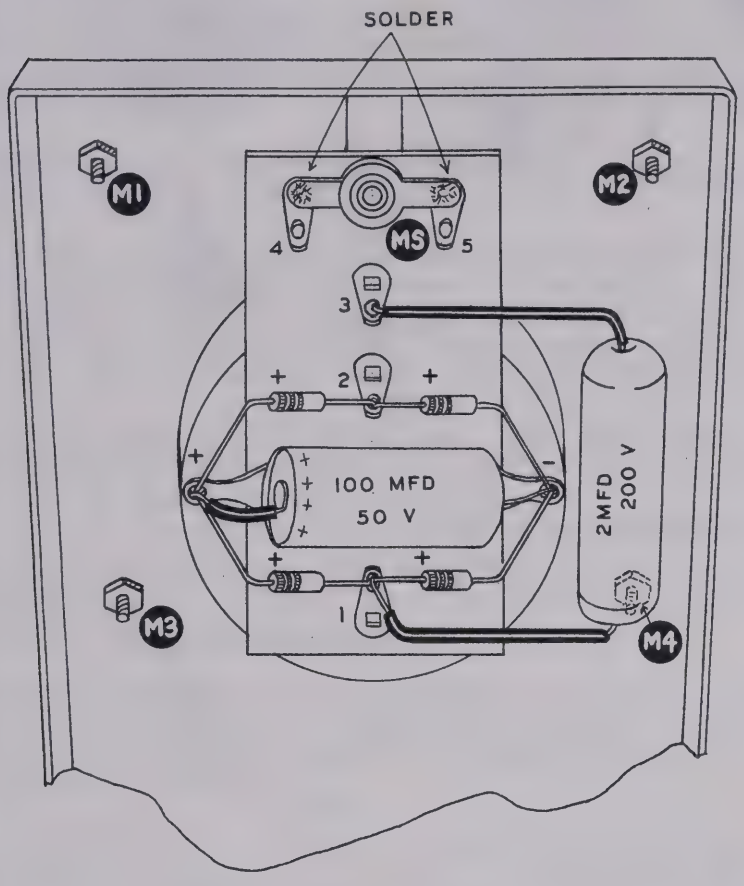


Figure 1

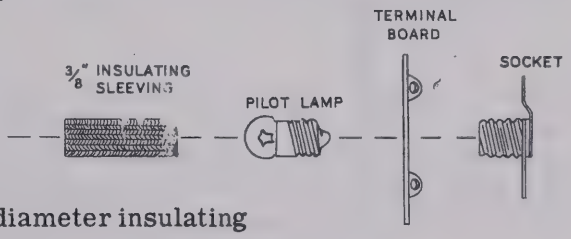


Figure 2

(✓) Install the pilot lamp in its socket. Slip the 3/8" diameter insulating sleeving over the pilot lamp. See Figure 2.

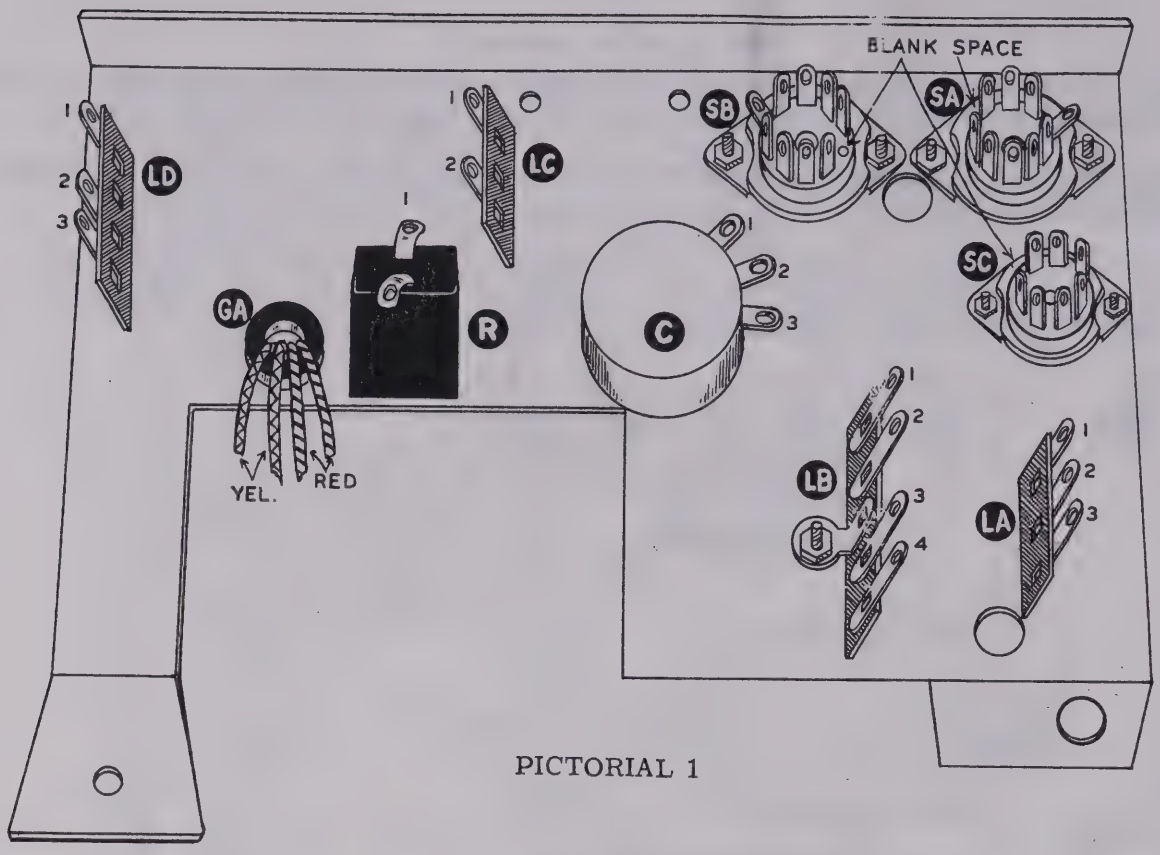
(✓) Remove one nut and the solder lug from each meter stud. NOTE: Hold the inner nut while loosening the outer nut, so no strain is placed on the plastic meter housing.

(✓) Mount the terminal board on the meter studs using the solder lugs and nuts that came with the meter.

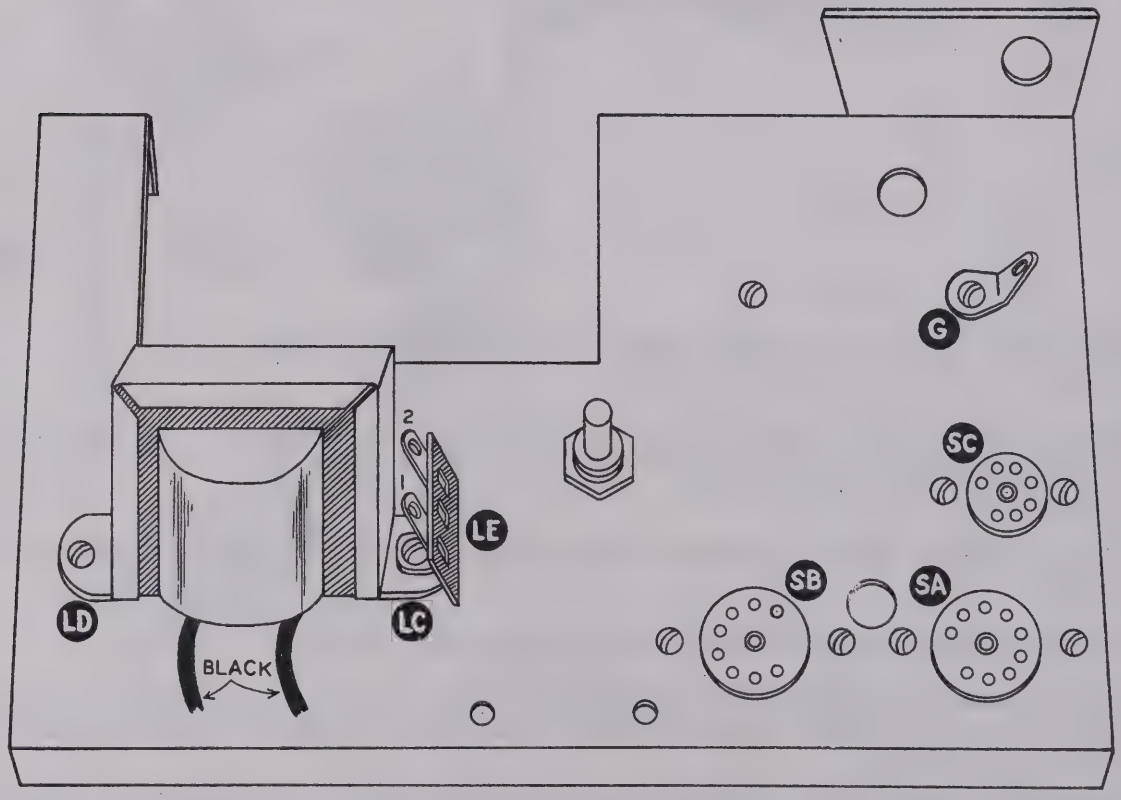
(✓) Slip the sleeving on the pilot lamp against the panel. See Figure 2.

(✓) Connect the cathode lead (marked with a band, bands, letter "K", arrow point or dot) of a crystal diode to lug 1 (NS). Connect the other lead to the negative (-) meter lug (NS). Refer to chart on page 21.

(✓) Connect the cathode lead of a crystal diode to the positive (+) terminal of the meter (NS). Connect the other lead to lug 1 (NS).



PICTORIAL 1



PICTORIAL 2

The Heathkit Audio Vacuum Tube Voltmeter, model AV-3, when properly constructed will represent a precision instrument capable of years of service. This manual is designed to assist you in every way to complete the instrument with the least possible chance of error. The step-by-step written instructions combined with the pictorials provide the fastest, most convenient way in which to assemble a kit.

The written instructions are divided into steps. Each step is a complete operation. Read the entire step through, then do the operation and check it off in the parenthesis ( ) at the beginning of that step. The major pictorials and figures are reproduced on large separate sheets. Fasten the appropriate drawing on the wall above your work space. This will save paging back and forth in the manual.

In the mechanical assembly, use lockwashers under all nuts unless solder lugs are used. These serve as lockwashers themselves.

All parts have been given a letter designation and each lug a number. Thus, in the step-by-step instructions, SA3 would refer to lug 3 on socket SA. In the wiring instructions (NS) means do not solder this connection yet as more wires will be connected to this point. When the connection is to be soldered the instructions will appear as follows (S-3), which means solder this connection, which should have three wires connected to it.

Precision resistors are marked with their resistance values. Carbon resistors are marked with colored bands indicating their resistance values. In the instructions the proper colors as well as the resistance values are given.

PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

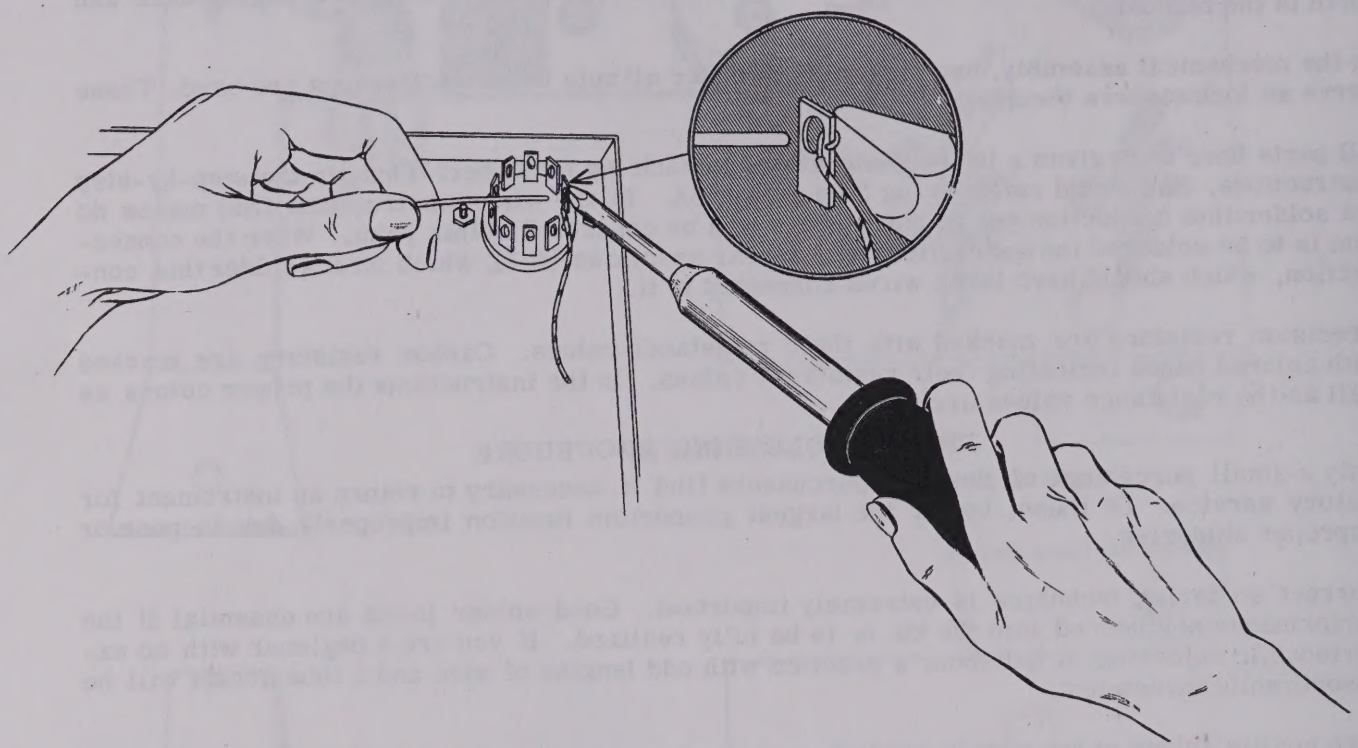
Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour's practice with odd lengths of wire and a tube socket will be a worthwhile investment.

High quality solder of the proper grade is most important. There are several different brands of solder on the market, each clearly marked "Rosin Core Radio Solder." Such solders consist of an alloy of tin and lead, usually in the proportion of 50:50. Minor variations exist in the mixture such as 40:60, 45:55, etc. with the first figure indicating the tin content. Radio solders are formed with one or more tubular holes through the center. These holes are filled with a rosin compound which acts as a flux or cleaning agent during the soldering operation.

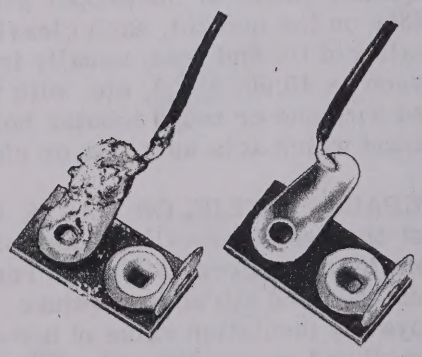
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes. Such compounds, although not corrosive at room temperatures, will form residues when heated. The residue is deposited on surrounding surfaces and attracts moisture. The resulting compound is not only corrosive but actually destroys the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will create erratic or degraded performance of the instrument.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.

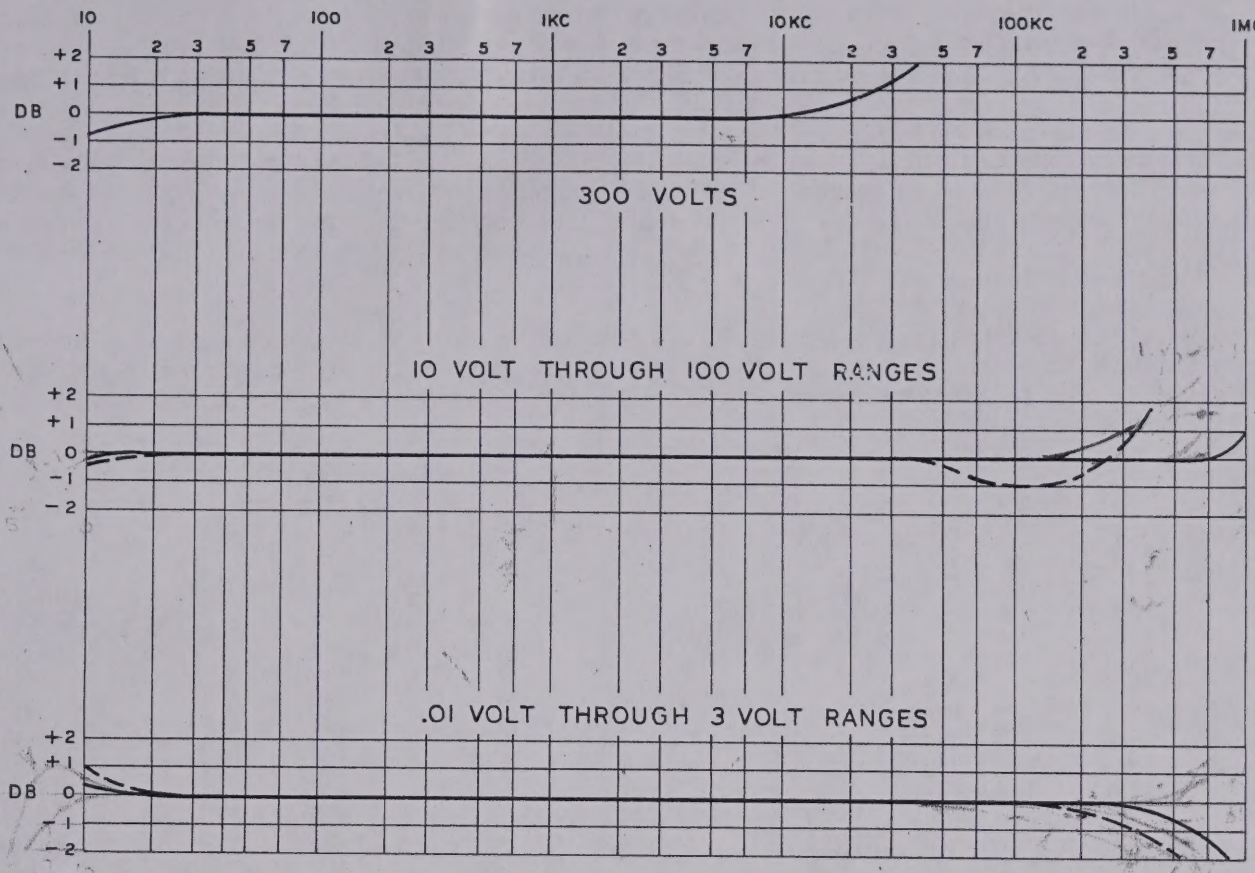


A poor solder joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface, caused by movement of the joint before it solidified is another evidence of a "cold" connection. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance. Photographs in the adjoining picture clearly indicate these two characteristics.



A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 60 or 100 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally during use.

Take these precautions and use reasonable care during assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.



These curves represent measurements made on several AV-3 Audio VTVM's built by different persons. They represent the performance which may be expected. The best and poorest responses are shown for the ranges indicated. Frequency response should fall between these limits. Lead dress and component placement will effect frequency response. The meters on which these measurements were made were calibrated at 1 kc on the 1 volt range.

When comparing an instrument of this kind with another instrument, consider that the instruments may deviate in opposite directions. Thus, two instruments, both within 1 db, may show a difference of 2 db. Critical comparison should be made only against an accurate laboratory standard AC voltmeter.

CIRCUIT DESCRIPTION

The Heath Audio VTVM, model AV-3 is a stable meter designed to measure AC voltages over a wide range of frequencies. A 12AT7 is connected in a cascode type circuit which provides very high gain with relatively low noise. The output of the cascode stage is coupled to the meter stage by a cathode follower. This increases the high frequency response of the amplifier as a whole as well as providing higher gain from the cascode stage, since it is not being loaded. This also adds to the stability of the circuit. The high gain makes possible a 10 millivolt full scale sensitivity.

Four diodes are used in a full-wave bridge circuit to provide DC for the 200 microampere meter. Current returns to ground through a 10 Ω control and a 30 Ω resistor. The 10 Ω control also connects to the cathode of the input stage, thus applying negative feedback. Calibration is obtained by adjusting this 10 Ω control which varies the amount of feedback to the cathode and consequently the gain.

The .01 volt to 3 volt ranges inclusive, are coupled to the cascode stage by a 6C4 connected as a cathode follower. The 10 volt to 300 volt ranges are coupled by a capacitor to the cascode stage. Good frequency response is thus obtained on all ranges without compensation.